

[REDACTED]

JUN 24 1996

Federal Communications Commission
Office of Secretary

Motion to Accept Late-Filed Comments

Respectfully Submitted,

By: Linda C. Sadler
Linda C. Sadler
Manager, Regulatory Affairs
Rockwell International Corporation
Suite 1200
1745 Jefferson Davis Highway
Arlington, VA 22202
(703) 412-6696

No. of Copies rec'd
111 ABCDEF

029

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of the Application of)	
)	
Amendment of Parts 2 and 15 of the)	ET Docket Number 96-8
Commission's Rules Regarding Spread)	
Spectrum Transmitters)	

Comments of Rockwell International Corporation

Pursuant to Section 1.415 of the Federal Communications Commission ("the Commission") Rules and Regulations, Rockwell International Corporation ("Rockwell") hereby submits an original and nine copies of Comments on the Notice of Proposed Rulemaking ("NPRM") regarding proposed modifications to Section 15.247 of the Commission's Rules covering unlicensed spread spectrum radio frequency systems.

INTRODUCTION

Rockwell is a diversified high technology company that manufactures a wide variety of radio frequency equipment for the aeronautical, maritime, private land mobile and satellite services as well as systems and devices authorized under Part 15 of the Commission's Rules and Regulations. Rockwell manufactures integrated microelectronic "chipsets" that act as spread spectrum transceivers for cordless telephones operating pursuant to Section 15.247 and is, therefore, a party in interest to this proceeding.

The subject NPRM addresses three Petitions for Rulemaking filed by manufacturers of spread spectrum systems and a number of other proposed modifications to the spread spectrum rules. Rockwell supports the Commission's efforts to update and revise the spread spectrum rules. However, as the Commission modifies some of the requirements

under those rules in order to achieve the objectives described in the NPRM and the various Petitions for Rulemaking, it should seek to maintain the underlying interference mitigating capabilities of the spread spectrum systems affected by the modifications. These interference mitigating capabilities are essential to the continued success of unlicensed spread spectrum operations in the ISM bands. Further, in modifying any portion of the spread spectrum rules, the Commission should guard against bestowing a competitive or technical advantage on any single spread spectrum technology. To assure that no particular spread spectrum technology is favored, the rules governing each technology should require each type of system to meet the same or comparable overall interference standards. Accordingly, in response to the Commission's request for comments on the various elements of the NPRM, Rockwell submits the following comments:

Western Multiplex Corporation Petition

- Unlicensed devices should not be permitted to operate using high gain antennas in the 915 MHz and 2450 MHz bands.
- If the Commission does permit unlicensed spread spectrum systems to use high gain antennas in the 5800 MHz band, the Commission should impose restrictions on the operation and installation of such systems to guard against potentially harmful interference to licensed and unlicensed systems in the band.

Symbol Technologies Petition

- Symbol's proposals would diminish the interference mitigating capabilities of frequency hopping systems and, if implemented, could cause unacceptable levels of interference to unlicensed devices operating in the 2450 and 5800 MHz ISM bands.
- Rockwell agrees with the Commission's conclusion that there are better alternatives for wireless delivery of wideband data.

SpectraLink Petition

- Rockwell believes that SpectraLink's stated objective, avoiding operations in the multilateration LMS bands, and its recognition that a reduction from 50 to 25 hops requires compensating measures to prevent interference, are reasonable.
- If the Commission allows a reduction in the number of hopping channels below 50, the Commission should adopt a formula specifying a decrease in transmit power with any

reduction in the number of hopping channels to ensure that systems operating with fewer than 50 hopping channels cause no increase in interference in the 915 MHz ISM band.

Power Spectral Density for Direct Sequence Spread Spectrum Systems

- The Commission's proposed 8 dBm peak power spectral density limit on direct sequence spread spectrum ("DSSS") systems is overly stringent for actual operations of DSSS systems that meet existing bandwidth and power requirements.
- The power spectral density limit should be changed to 8 dBm RMS power instead of peak power (excluding off periods for duty cycled systems) using the measurement procedure in Appendix B.

A detailed discussion of the above recommendations is contained in the following "Discussion" section as are comments on some of the other "Additional Proposals" in the NPRM.

DISCUSSION

Western Multiplex Corporation Petition

Rockwell generally agrees with the Commission's conclusions on the Western Multiplex Corporation ("WMC") Petition. High gain antennas should not be allowed to operate in the 915 MHz and 2450 MHz bands. Unlicensed use of high gain antennas could cause unacceptable interference to widely used portable consumer Part 15 systems such as cordless telephones which are already deployed in the 915 MHz ISM band. The projected wide proliferation of wireless LAN systems in the 2450 MHz ISM band could also be adversely affected by the deployment of high gain antennas. The public will be better served by the continued deployment of unlicensed systems such as cordless telephones and wireless LANs in the 915 and 2450 MHz ISM bands because of the lower cost and lower power requirements for systems operating in those bands.

If the Commission allows the use of high gain antennas with unlicensed spread spectrum systems operating in the 5800 MHz ISM band, it should limit the transmit power of

systems using high gain antennas. The proposed 1 dB reduction in transmit power for every 3 dB of additional antenna gain over 6 dBi is acceptable, assuming free space propagation conditions.

If the Commission allows spread spectrum systems operating in the 5800 MHz ISM band to use high gain antennas with effective radiated power in excess of 1000 watts as the NPRM contemplates,¹ such systems should be regulated more strictly than their Section 15.247 counterparts using omnidirectional antennas because of their increased potential to cause harmful interference. As the Commission has proposed, high gain antennas should not be used for consumer systems or devices, but rather for fixed point-to-point service only. Even with such a restriction, the Commission has raised a number of concerns with the unlicensed operation of high gain antennas including interference to licensed services, cross border interference, radiation hazards and labeling. Instead of attempting to develop an exhaustive list of regulations for the use of unlicensed spread spectrum systems using high gain antennas, the Commission could a) develop a set of installation and interference guidelines with industry input and assistance and b) require that high gain antennas be installed only by the grantee of equipment authorization for the spread spectrum transmitter or by entities contracted by the grantee.

Under this scenario, the grantee or its contractors would follow installation guidelines established jointly by the Commission and industry to control interference to both licensed and unlicensed systems, prevent transborder interference and reduce the risk of exposure to radiation hazards. Rockwell submits that, while certain users of these unlicensed fixed systems, such as SMR operators and federal and state governments, might possess a high degree of radio frequency expertise, it cannot be assumed that all potential users, or the users' radio frequency systems contractors, will possess the expertise necessary to properly install high gain antennas for use with unlicensed systems and safeguard against interference, radiation hazards, etc. Installation and interference guidelines and grantee

¹ See Notice of Proposed Rulemaking, FCC 96-36, In the Matter of Amendment of Parts 2 and 15 of the Commission's Rules and Regulations Regarding Spread Spectrum Transmitters, footnote No. 9.

responsibility for installation could provide the necessary safeguards to allow Section 15.247 systems to operate using high gain antennas without requiring that users be subjected to licensing.

Symbol Technologies, Inc. Petition

Rockwell supports the Commission's dismissal of the Symbol Technologies, Inc. ("Symbol") Petition. Symbol's proposals would diminish the interference mitigating characteristics, and thus the value, of frequency hopping systems in the 2450 and 5800 MHz ISM bands in order to produce a less costly, wider bandwidth data application. Rockwell believes that the proposed trade off is not in the public interest and agrees with the Commission's conclusion that there are better alternatives for the delivery of wideband wireless data including the 5 GHz SUPERNet/NII services proposed by the Wireless Information Networks Forum ("WINForum") and Apple Computer.²

Rockwell believes that Symbol's proposed rule modifications could cause unacceptable levels of interference in the 2450 and 5800 MHz ISM bands. Symbol proposes to significantly reduce the minimum number of hopping channels required in these bands from 75 to 20 and reduce the peak power output limit from one watt to (number of hops/75) watts. The proposed modifications would result in frequency hopping systems with increased duty cycles thereby increasing the probabilities of collisions with other systems. In addition, frequency hopping systems using fewer hops and wider bandwidths will have lower tolerance of narrowband jammers, causing the frequency hopping systems to transmit more often and with more power in order to overcome such jammers. For these reasons, Rockwell supports the Commission's decision not to adopt Symbol's petition.

² See Notice of Proposed Rulemaking, FCC 96-193, In the Matter of Amendment of the Commission's Rules to Provide for Unlicensed NII/SUPERNet Operations in the 5 GHz Frequency Range

SpectraLink Corporation Petition

Like Symbol, SpectraLink Corporation ("SpectraLink") seeks to trade a degree of the interference mitigating ability of frequency hopping systems to achieve a specific objective, in this case avoiding interference with the multilateration systems operating under the Location and Monitoring Service ("LMS") rules in the 915 MHz ISM band. However, there are several important differences between the Symbol and SpectraLink petitions. First, SpectraLink seeks to lower the minimum number of hopping channels in order to avoid potential interference problems between frequency hopping systems and multilateration LMS systems in the 915 MHz ISM band. Rockwell believes that potentially serious interference problems could develop between unlicensed devices and multilateration LMS systems and therefore understands SpectraLink's stated motivation for seeking to lower the minimum number of hopping channels. Second, SpectraLink's proposed modifications are not as severe as those proposed by Symbol and therefore not as detrimental to the interference mitigating capability of frequency hopping systems. Third, in advancing the proposed modifications, SpectraLink and the Commission have recognized that if certain requirements are loosened to accomplish SpectraLink's objective, other requirements must be tightened in order to protect the band from increased interference.

In adopting any variation of SpectraLink's proposals, the Commission should ensure that the portion of the 915 MHz band which is not used by multilateration LMS systems is not adversely affected by frequency hopping systems using less than 50 hops. Further, the Commission should ensure that the measures it adopts do not bestow competitive or technical advantages on any particular type of spread spectrum system operating in the 915 MHz ISM band. SpectraLink and the Commission have proposed a number of measures to compensate for the proposed decrease in the minimum number of hopping channels: first, limiting the reduction in the number of hopping channels to a minimum of 25; second, limiting maximum output power to 500 mW when using less than 50 hopping channels; and third, requiring a minimum bandwidth of 250 kHz when using less than 50 hopping channels. Beyond these and other measures proposed in the NPRM, Rockwell

believes that there should also be a formula specifying a decrease in transmit power with any reduction in the number of hopping channels. Itron's proposed linear power reduction, however, will not provide sufficient protection from interference for other spread spectrum systems operating in the band.³

Power Spectral Density

Rockwell agrees with the Commission's reason for imposing a power spectral density ("PSD") limit on DSSS systems, to "ensure that the transmitted energy is spread evenly over the channel bandwidth."¹ However, Rockwell believes that there are two problems with the Commission's 8 dBm peak PSD limit. First, the 8 dBm peak limit is overly stringent because it was derived using assumptions that are not applicable to practical DSSS signals. Second, even if the Commission were to take the characteristics of practical DSSS signals into account in deriving a less stringent peak PSD limit, Rockwell believes that peak PSD measurements yielded by the Commission's measurement procedure for DSSS signals, as described in Appendix C of the NPRM, do not fairly reflect the interference potential of DSSS systems. A technical analysis explaining these two problems in more detail is attached to these Comments as Appendix A.

DSSS systems, in spite of fully complying with the Commission's bandwidth and power output requirements, can fail the PSD test due to the characteristics of practical DSSS signals. In order to comply with the Commission's peak PSD limit, DSSS system manufacturers must reduce their products' output power by almost 10 dB from the allowed one watt limit, increasing the vulnerability of those products to interference from other types of systems, such as frequency hopping systems, which are not subject to PSD limits. Consequently, Rockwell submits that the PSD limit should be changed to 8 dBm RMS power instead of peak power (excluding off periods for duty cycled systems). Rockwell proposes a measurement procedure to determine RMS power in Appendix B.

³ Supra, No. 1, page 16, paragraph 33.

Definition of Direct Sequence

Rockwell agrees with the Commission's proposed definition for direct sequence systems. However, the Commission should add language to ensure the independence of the "high speed spread code" of a direct sequence system from the modulation technique used by the system to create the "information data stream", such as BPSK or FSK modulation. The spreading method should also be independent from multi-access methods such as TDMA or FDMA. Rockwell believes such language is necessary to ensure systems are not authorized that partially rely on the modulation of the information data stream to meet the Commission's 10 dB processing gain requirement, thus violating the intent of that requirement.⁴

Coordination of Frequency Hopping Systems

Rockwell agrees with the NPRM's proposal that the Commission should approve "intelligent" frequency hopping devices with the capability to independently and individually choose and adapt entire hop sets. However, it should be noted that allowing coordination of frequency hopping systems or authorizing systems capable of synchronizing their hopping patterns with other frequency hopping systems would remove the randomness from the system and thus would damage the overall interference mitigating capabilities of frequency hopping systems. Further, the ability to synchronize with the hopping patterns of other systems weakens the incentive to build systems with high processing gain. Rockwell believes that manufacturers should be allowed to employ any multi-access technology available, providing that it is independent of their systems' spreading capability, in this case, pseudorandom frequency hopping.

⁴ Ibid., page 19, paragraph 41.

Measurement of Processing Gain


In response to the Commission's invitation for comments on or alternatives to the NPRM's proposed new procedure for measuring processing gain, Rockwell submits an alternative method in Appendix C.

CONCLUSION

In modifying the spread spectrum rules, whether relaxing requirements to achieve certain objectives, or revising outmoded definitions, the Commission should consider the impact of its modifications not only on the specific class of systems to which the modifications pertain, but also on the overall environment in which all unlicensed systems operate and on the relationships between the directly affected class of systems and competing unlicensed technologies. In the NPRM's treatment of the WMC and SpectraLink petitions, the Commission has both embraced and proposed measures to protect the unlicensed bands from harmful increases in interference resulting from the proposed use of high gain antennas in the 5800 MHz ISM band and frequency hopping systems with fewer than 50 hopping channels in the 915 MHz ISM band. Rockwell recommends that the Commission also balance the field of competition between frequency hopping and direct sequence systems by adopting Rockwell's proposed RMS power limit set forth in Appendix B as the power spectral density requirement for direct sequence systems.

Respectfully Submitted,

Rockwell International Corporation

By: 

Linda C. Sadler

Manager, Governmental Affairs

Rockwell International

Suite 1200

1745 Jefferson Davis Highway

Arlington, VA 22202

(703) 412-6696

June 21, 1996

Wireless Communications Division
Rockwell International Corporation
4311 Jamboree Road
Newport Beach, CA 92660
(714) 221-3338



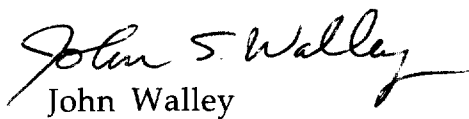
John S. Walley
Manager
Digital Cordless Products

June 20, 1996

DECLARATION

I am the technically qualified person responsible for preparation of the foregoing engineering analysis and test procedure. I am familiar with the applicable portions of Part 15 of the Commission's Rules and Regulations and the technical parameters discussed in the analysis.

I declare that the foregoing is true and correct to the best of my knowledge, information and belief.


John Walley

Appendix A

Power Spectral Density Requirement For Direct Sequence Systems

Rockwell agrees with the Commission's reason for imposing a power spectral density ("PSD") limit on DSSS systems but believes that there are two problems with regulating "peak" power in a 3 kHz bandwidth.

1.0 The first problem is with the selected peak limit. It is Rockwell's understanding that the present limit of 8 dBm was derived by estimating the power in any 3 kHz bandwidth within the minimum 500 kHz signal bandwidth of a one watt spread spectrum transmitter using the following formula:

$$10*\log(1W*3kHz/500kHz)=8dBm$$

Rockwell understands the Commission's goal of estimating the receive power using this formula and agrees with its use. However, the formula only applies to average input and output power for a linear time invariant test receiver with a flat input PSD, and a flat test receiver response. Use of this formula when the test receiver bandwidth is very low compared to the input signal is valid for peak power level estimation only when the transmitted signal is a Gaussian random process with a flat PSD. Practical DSSS systems do not exhibit this characteristic. For example, for any transmit signal that has a one watt average power level spread flat across the 500 kHz band, 8 dBm would be the average power in the 3 kHz test receiver. Also consider the following example: for a one watt CW transmit signal that slowly sweeps across the 500 kHz band, the average power in a 3 kHz test receiver, using the above formula, will be correct but the peak output will be one watt if the CW sweep rate is lower than the peak estimation window.

Practical DSSS transmitted signals have a near constant envelope when modulated with FSK, BPSK, and other similar techniques. The average and peak power levels using these modulation techniques are approximately the same during transmission. When the existing rules specify a peak power limit of one watt for DSSS systems, the typical average power will also be near one watt. Thus, when the above formula is applied, for a one watt average power DSSS system, the average receiver power in the 3 kHz test receiver will be 8 dBm. This is true even though the peak transmit signal is one watt. If the test receiver output is measured using peak detection, higher peak levels above the 8 dBm limit are necessary.

2.0 Second, even if the PSD levels were increased above 8 dBm to correctly reflect true peak levels from a test receiver with DSSS inputs, measuring peak power levels from a test receiver output is not a good reflection of true interference potential.

Appendix A (continued)

The output of a linear time invariant test receiver can be calculated by convolving the impulse response of the test receiver filter response and the input signal. When the test receiver bandwidth is very small relative to the input signal bandwidth, the impulse response in the time domain will be very wide compared to the input signal. The output of the convolution integral will be, under these circumstances, basically a sum of a large portion of the input signal. Because the input signal is noise like and the output signal is a sum of a large portion of the input signal, the Central Limit Theorem approximates what the test receiver output signal distribution will be - a Gaussian process.

Estimations of what the peak power levels will look like relative to the average power at the output of the test receiver with a 3 kHz bandwidth can be made because the process is approximately Gaussian. For example, peak levels 10 dB above the average power have a 0.1% probability of occurrence (3 Sigma) at the receiver output. With this type of signal, large peaks can occur but with very low probabilities. Because peaks, at the test receiver output, of 10 dB and higher over the average power can occur, despite the extremely low probability that they will occur, measuring peak value over long intervals may not be a fair metric to reflect the true interference potential of these Gaussian-like random signals.

DSSS systems, in spite of fully complying with the Commission's bandwidth and power output requirements, can fail the PSD test due to the characteristics of practical DSSS signals. In order to comply with the Commission's peak PSD limit, DSSS system manufactures must reduce their products' output power by almost 10 dB from the allowed one watt limit, increasing the vulnerability of those products to interference from other types of systems, such as frequency hopping systems, which are not subject to PSD limits. Consequently, Rockwell submits that the PSD limit should be changed to 8 dBm RMS power instead of peak power (excluding off periods for duty cycled systems). Rockwell proposes a measurement procedure to determine RMS power in Appendix B.

Appendix B

Proposed Power Spectral Density Measurement Procedures

Current Procedure:

Section 15.247(d), Power Spectral Density:

Locate and zoom in on emission peak(s) within the passband. Set RBW=3 kHz, VBW>RBW, sweep=(SPAN/3 kHz) e.g., for a span of 1.5 MHz, the sweep should be $1.5 \times 10^6 \div 3 \times 10^3 = 500$ seconds. The peak level measured must be no greater than + 8 dBm. If external attenuation is used, don't forget to add this value to the reading. Use the following guidelines for modifying the power spectral density measurement procedure when necessary.

The above method is valid only for random code/data modulation. In the case of practical spread spectrum systems with pseudo random codes, the peak and average will be different by approximately 10 dB after the signal is greatly bandlimited.

Proposed Procedure:

Use the same spectrum analyzer settings as the current procedure above. RMS power in 3 KHz band width may be measured using the noise density function. On most modern conventional spectrum analyzers, the noise marker function directly measures the RMS noise power density normalized to a 1 Hz bandwidth.

- The noise marker function should be enabled, and the maximum signal power measured for the TX spectrum.
- The noise marker function reads RMS power in a 1 Hz bandwidth . The noise marker value measured should then be derated for the duty cycle of the system to get RMS power estimate for transmission time only.
- $[10 \cdot \log(3 \text{ kHz})] = 35 \text{ dB}$ should then be added to the noise marker function to normalize the RMS noise power to 3 kHz.

The RMS noise power in any 3 kHz bandwidth shall be < 8 dBm

Appendix C

Proposed Alternative Method for the Measurement of Processing Gain

Following is an alternative method for measuring the processing gain of DSSS systems

White Noise Jammer Method

This method essentially uses a broadband white noise interference source to characterize the jamming margin of the subject system in place of a CW source, essentially estimating E_c/N_0 to E_b/N_0 ratio where E_c is DSSS chip energy. Most of the commercially available noise sources can provide accurately controlled noise power with a typical resolution of 0.1 dB.

Step 1) Obtain the E_b/N_0 ratio required for an ideal demodulator for the desired bit error rate and the modulation scheme used. The E_b/N_0 ratio can be calculated from the corresponding equation for probability of error verses E_b/N_0 .

Step 2) Measure the input receive signal power using a power meter. Measure or obtain the DS chipping rate. The chipping rate can be computed by measuring $1/2$ *the null to null bandwidth of the DSSS spectrum. E_c is equal to input power*1/Chipping rate.

Step 3) Increase the noise power while measuring the bit error rate of the system such that the bit error rate increases to the maximum tolerable limit of the system ($1*10^{-3}$ for example). Ensure that the noise power level is much higher than the noise floor of the system.

Step 4) Calculate the Processing Gain:

Demod Performance	E_b/N_0 for the measured BER
System Losses	L_{sys} = system losses in dB (max 2 dB)
Input Performance	E_c/N_0 for the measured BER
Processing Gain	$G_p = 10*\log(E_b/N_0)-10*\log(E_c/N_0)+L_{sys}$

This method only requires one measurement. Accuracy is limited in some cases to approximately 1 dB because of the amount of extra filtering done in the receive system in addition to the matched filter.